

**AMENDMENTS TO THE CLAIMS**

Please amend claims 1, 3-4, 6-12, 14, 15-25, 28-29, 34, 36-37, and 39, and cancel claims 2 and 35 as set forth in the listing of claims that follows.

1. **(Currently amended)** A NOX abatement system, comprising:

a first NOX adsorber ~~(18)~~ disposed in-line, capable of being disposed downstream of and in fluid communication with an engine ~~(12)~~;

a selective catalytic reduction catalyst ~~(20)~~ disposed in-line, downstream of and in direct fluid communication with the first NOX adsorber ~~(18)~~; wherein the selective catalytic reduction catalyst ~~(20)~~ is adapted for ~~capable of~~ storing ammonia; ~~and~~

an off-line reformer ~~(24)~~ disposed in selective communication with and upstream of the first NOX adsorber ~~(18)~~ and the selective catalytic reduction catalyst ~~(20)~~, wherein the reformer ~~(24)~~ is capable of producing a reformat comprising primarily hydrogen and carbon monoxide; and

a first oxidation catalyst and a particulate filter disposed in-line, upstream of and in fluid communication with the first NOX adsorber, and said particulate filter includes a water gas shift catalyst.

2. **(Canceled)**

3. **(Currently amended)** The system of Claim 1 ~~2~~, further comprising a second oxidation catalyst ~~(36)~~ disposed in-line, downstream of and in direct fluid communication with the selective catalytic reduction catalyst ~~(20)~~, wherein the second oxidation catalyst ~~(36)~~ comprises a zeolite.

4. **(Currently amended)** The system of Claim 3, wherein the second oxidation catalyst ~~(36)~~ comprises a zeolite under-layer comprising the zeolite, wherein the zeolite under-layer is catalytic metal free.

5. **(Currently amended)** The system of Claim 4 3, wherein the zeolite is present in an amount greater than or equal to about 20 wt%, based on the total weight of the zeolite under-layer.

6. **(Currently amended)** The system of Claim 4 3, wherein the zeolite has a Si/Al molar ratio of greater than or equal to about 12.

7. **(Currently amended)** The system of Claim 1 2, wherein the water gas shift catalyst is capable of maintaining, within about  $\pm 2$  vol%, a hydrogen concentration in an exhaust stream passing through the particulate filter (46), based upon a total volume of hydrogen entering the particulate filter (46) compared to a total volume of hydrogen exiting the particulate filter (46).

8. **(Currently amended)** The system of Claim 1 2, wherein the water gas shift catalyst is capable of increasing a hydrogen concentration in an exhaust stream to greater than or equal to about 20 vol.%, based upon a total volume of the exhaust stream exiting the particulate filter (46).

9. **(Currently amended)** The system of Claim 1, further comprising a first oxidation catalyst (44) and a particulate filter (46) disposed in-line, upstream of and in fluid communication with the first NOX adsorber (48), wherein the first oxidation catalyst (44) comprises an oxidation catalyst capable of partially oxidizing greater than or equal to about 60 vol.% of hydrocarbons, based upon a total amount of hydrocarbons in an exhaust stream entering the first oxidation catalyst (44).

10. **(Currently amended)** The system of Claim 9, wherein the oxidation catalyst (44) is capable of partially oxidizing greater than or equal to about 75 vol% of the hydrocarbons.

11. **(Currently amended)** The system of Claim 10, wherein the oxidation catalyst (44) is capable of partially oxidizing greater than or equal to about 85 vol% of the hydrocarbons.

12. **(Currently amended)** The system of Claim 9, wherein the oxidation catalyst ~~(44)~~ comprises:

a Part 1 component comprising a Part 1 support material having an agglomeration of primary particles, wherein an agglomeration size, measured along a major diameter, is about 5 micrometers to about 15 micrometers, and wherein the primary particle size is less than or equal to about 300 nanometers; and

a Part 2 component comprises a primary particle size of less than or equal to about 500 nanometers and a Part 2 agglomerate size of less than or equal to about 0.5 micrometers.

13. **(Original)** The system of Claim 12, wherein the ratio of the Part 1 component to the Part 2 component is about 80:20 to about 20:80.

14. **(Currently amended)** The system of Claim 12, wherein the Part 2 component comprises a solid solution selected from the group consisting of titanium-zirconium oxide, yttrium-zirconium oxide, barium-zirconium oxide, lanthanum-titanium oxide and the like, as well as combinations comprising at least one of the foregoing [1].

15. **(Currently amended)** The system of Claim 1, further comprising an in-line by-pass conduit ~~(34)~~ capable of being disposed in fluid communication with the engine ~~(12)~~ and the selective catalytic reduction catalyst ~~(20)~~, and an in-line by-pass valve ~~(30)~~ in fluid communication with the by-pass conduit ~~(34)~~ and the first NOX adsorber ~~(18)~~, wherein the by-pass valve ~~(30)~~ is capable of diverting an exhaust stream around the first NOX adsorber ~~(18)~~ via the by-pass conduit ~~(34)~~ to the selective catalytic reduction catalyst ~~(20)~~.

16. **(Currently amended)** The system of Claim 15, further comprising a second NOX adsorber ~~(118)~~ disposed downstream of the by-pass valve ~~(30)~~ and upstream of the selective catalytic reduction catalyst ~~(20)~~ such that when the exhaust stream is diverted around the first NOX adsorber ~~(18)~~ the exhaust stream passes through the second NOX adsorber ~~(118)~~ prior to entering the selective catalytic reduction catalyst ~~(20)~~.

17. **(Currently amended)** The system of Claim 1, further comprising:  
an off-line burner ~~(38)~~ disposed upstream of and in fluid communication with the reformer ~~(24)~~; and  
an off-line reactor ~~(44)~~ in fluid communication with and disposed downstream of the reformer ~~(24)~~, wherein the reactor ~~(44)~~ comprises an ammonia forming catalyst.

18. **(Currently amended)** The system of Claim 17, further comprising an off-line heat exchange ~~(64)~~ device in thermal communication with a passenger compartment, wherein the heat exchange device is downstream of and in fluid communication with the burner ~~(38)~~.

19. **(Currently amended)** The system of Claim 1, wherein the first NOX adsorber ~~(18)~~ comprises a catalyst capable of converting adsorbed NOX to ammonia.

20. **(Currently amended)** The system of Claim 1, wherein the first NOX adsorber ~~(18)~~ comprises a NOX trapping material and a sufficient amount of a hydrophobic material to render the NOX trapping material hydrophobic.

21. **(Currently amended)** The system of Claim 20 ~~1~~, wherein the hydrophobic material is present in an amount of about 0.1 wt% to about 2 wt%, based on a NOx combined weight.

22. **(Currently amended)** The system of Claim 1, wherein the reformer ~~(24)~~ comprises a hexaaluminate support.

23. **(Currently amended)** The system of Claim 1, wherein the NOX adsorber ~~(18)~~ comprises a substrate and a protective coating coated on the substrate, wherein the protective coating comprises phosphate.

24. **(Currently amended)** A method of NOX abatement, comprising:  
storing engine NOX from an exhaust stream in a initial NOX adsorber ~~(18)~~ during a storage phase;  
forming reformat comprising primarily hydrogen and carbon monoxide in an off-line reformer (24) during a regeneration phase;  
reacting the reformat with the stored NOX to produce greater than or equal to about 5,000 ppm ammonia during the regeneration phase; and  
storing the ammonia in a selective catalytic reduction catalyst ~~(20)~~ during the regeneration phase.
25. **(Currently amended)** The method of Claim 24, further comprising by-passing the exhaust stream around the initial NOX adsorber ~~(18)~~ during the regeneration phase.
26. **(Original)** The method of Claim 24, further comprising reacting NOX in the by-passed exhaust stream with the stored ammonia.
27. **(Withdrawn)** The method of Claim 24, further comprising storing NOx in the by-passed exhaust stream in a by-pass NOX adsorber (118) during the regeneration phase, and reacting the stored by-pass NOX with the reformat during a storage phase of the initial NOX adsorber (18).
28. **(Currently amended)** The method of Claim 24, further comprising reacting exhaust gas recirculation in the reformer ~~(24)~~ to produce hydrogen.

29. **(Currently amended)** The method of Claim 24, further comprising filtering the exhaust stream; and water gas shifting water in the exhaust stream in a filter ~~(44)~~ to hydrogen prior to storing the engine NOX; wherein the water gas shifted stream comprises greater than or equal to about 20 vol% hydrogen exiting the filter, based upon a total volume of the exhaust stream exiting the filter.

30. **(Original)** The method of Claim 29, wherein the water gas shifted stream comprises greater than or equal to about 26 vol% hydrogen exiting the filter, based upon a total volume of the exhaust stream exiting the filter.

31. **(Original)** The method of Claim 24, further comprising partially oxidizing hydrocarbons in the exhaust stream prior to storing the engine NOX, wherein greater than or equal to about 60 vol.% of the hydrocarbons are partially oxidized, based upon a total volume of hydrocarbons in the exhaust stream prior to the partial oxidation.

32. **(Original)** The method of Claim 31, wherein greater than or equal to about 75 vol% of the hydrocarbons are partially oxidized.

33. **(Original)** The method of Claim 32, wherein greater than or equal to about 85 vol% of the hydrocarbons are partially oxidized.

34. **(Currently amended)** A NOX abatement system, comprising:

an in-line selective catalytic reduction catalyst (20) capable of being disposed in fluid communication with an engine (12), wherein the selective catalytic reduction catalyst (20) is adapted for capable of storing ammonia;

an off-line reformer (24) in fluid communication with the selective catalytic reduction catalyst (20), wherein the reformer (24) is capable of producing a reformat (24) comprising primarily hydrogen and carbon monoxide; and

an off-line reactor (44) in fluid communication with and downstream of the reformer (24), wherein the reactor (44) comprises an ammonia forming catalyst;

an off-line burner in fluid communication with and upstream of the reformer and the reactor.

35. **(Canceled)**

36. **(Currently amended)** The system of Claim 34 ~~35~~, further comprising an off-line mixing chamber (42) disposed upstream of the reactor (44), downstream of and in fluid communication with the reformer (24), and in direct fluid communication with the burner (38).

37. **(Currently amended)** A method of NOX abatement, comprising:

burning fuel off-line to form burner NOX;

forming a reformat comprising primarily hydrogen and carbon monoxide, off-line;

reacting the burner NOX with the reformat to form ammonia, off-line;

storing the ammonia in an in-line selective catalytic reduction catalyst;

introducing engine NOX to the selective catalytic reduction catalyst (20); and reacting the engine NOX with the ammonia.

38. **(Original)** The method of Claim 37, wherein the burner NOX and the reformat are reacted at a temperature of about 120°C to about 400°C and a pressure of about 15 kPa to about 150 kPa.

39. **(Currently amended)** The method of Claim 37, further comprising periodically regenerating the selective reduction catalyst ~~(20)~~ by periodically forming the ammonia and periodically introducing the ammonia to the selective catalytic reduction catalyst ~~(20)~~.

40. **(Original)** The method of Claim 37, further comprising heating a passenger compartment of a vehicle with the burner NOX.

41. **(Withdrawn)** A NOX abatement system, comprising:  
an off-line membrane (70) capable of inhibiting passage of oxygen through the membrane (70);  
an off-line reformer (82) disposed downstream of and in fluid communication with the membrane (70) and a fuel source (26), wherein the reformer (24) is capable of producing ammonia from fuel and nitrogen; and  
an in-line selective catalytic reduction catalyst (20) disposed downstream of and in fluid communication the reformer (82), wherein the selective catalytic reduction catalyst (20) is capable of storing ammonia and capable of receiving NOx from an engine (12).

42. **(Withdrawn)** The system of Claim 41, wherein the reformer (82) comprises a pressure controlled container capable of operating at a pressure of about 20 atmospheres to about 100 atmospheres.

43. **(Withdrawn)** The system of Claim 41, wherein the pressure is about 20 atmospheres to about 40 atmospheres.



44. **(Withdrawn)** A method of NOX abatement, comprising:

passing air having an initial nitrogen concentration through a membrane (70) to form a membrane effluent having a subsequent nitrogen concentration, wherein the subsequent nitrogen concentration is greater than the initial concentration;

mixing the membrane effluent and a fuel (26) in a mixing chamber disposed upstream of and in fluid communication with a reformer (82);

introducing the mixed air and fuel into the reformer (82) to produce a reformat comprising ammonia;

periodically introducing the ammonia to a selective catalytic reductive catalyst (20) to regenerate the catalyst; and

reacting the ammonia stored in the selective catalytic reductive catalyst (20) with NOX in an exhaust fluid.

45. **(Withdrawn)** A NOX abatement system, comprising:

an in-line non-thermal plasma reactor (86) capable of being disposed downstream of and in fluid communication with an engine (12);

an in-line selective catalytic reduction catalyst (20) disposed downstream of and in direct fluid communication with the non-thermal plasma reactor (86); and

an off-line reformer (24) disposed upstream of and in fluid communication with the selective catalytic reduction catalyst (20).

46. **(Withdrawn)** The system of Claim 45, wherein the non-thermal plasma reactor (86) is capable of controlling a ratio of NO to NO<sub>2</sub> in an exhaust stream from the engine, wherein the ratio can be controlled to about 1:0.6 to about 1:1.5 at temperatures less than or equal to about 200°C.

47. **(Withdrawn)** A method of NOX abatement, comprising:

introducing an engine exhaust stream to a non-thermal plasma reactor (86);  
reacting NOx in the exhaust stream to form a non-thermal plasma reactor effluent having a ratio of NO to NO2 of about 1:0.6 to about 1:1.5 at temperatures of less than or equal to about 200°C;  
forming reformat comprising primarily hydrogen and carbon monoxide;  
introducing the non-thermal plasma reactor effluent and the reformat to a selective reduction catalyst; and  
reducing the NOX to nitrogen.

48. **(Withdrawn)** The method of Claim 47, wherein the reformat is periodically introduced to the selective catalytic reduction catalyst (20).